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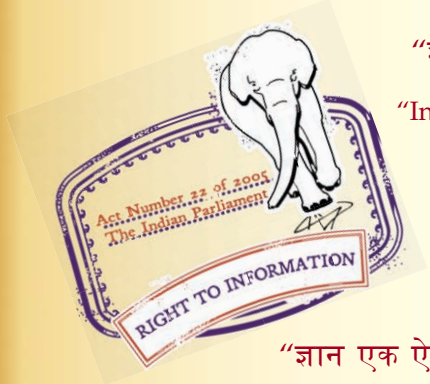

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CODE OF PRACTICE FOR CONTROL OF AIR POLLUTION IN INTEGRATED ALUMINIUM INDUSTRIES

UDC 628·511·006 76 : 669-71·013·52

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
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March 1988

Indian Standard

CODE OF PRACTICE FOR CONTROL OF AIR POLLUTION IN INTEGRATED ALUMINIUM INDUSTRIES

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Indian Standard

CODE OF PRACTICE FOR CONTROL OF AIR POLLUTION IN INTEGRATED ALUMINIUM INDUSTRIES

0. FOREWORD

0.1 This Indian Standard was adopted by the Bureau of Indian Standards on 30 July 1987, after the draft finalized by the Air Quality Sectional Committee had been approved by the Chemical Division Council.

0.2 In the recent years, great concern has been universally expressed regarding environmental pollution arising as a side effect of industrial and other human activities. It has now been recognized generally that these pollutants ultimately discharged in the working environment pose health hazards, producing chronic effects on living organisms including human beings.

0.3 An integrated aluminium complex consists mainly of the alumina plant, where bauxite is converted to alumina, the smelter or the reduction plant, where alumina is converted to primary aluminium and the fabrication plant where primary aluminium is converted to various fabricated and semi-fabricated end-products. Auxiliary installations like captive power plant, bauxite mines, foundry, etc, are also existing. Each of these units, to a different degree, is a source of air pollution. Figure 1 gives the main sources of air pollution in an integrated aluminium complex.

0.4 This standard is formulated to help the industry to identify the source and also to take suitable action for pollution abatement.

0.4.1 The recommended dust and mist collectors for abatement of pollution in an integrated aluminium plant is given in Fig. 2.

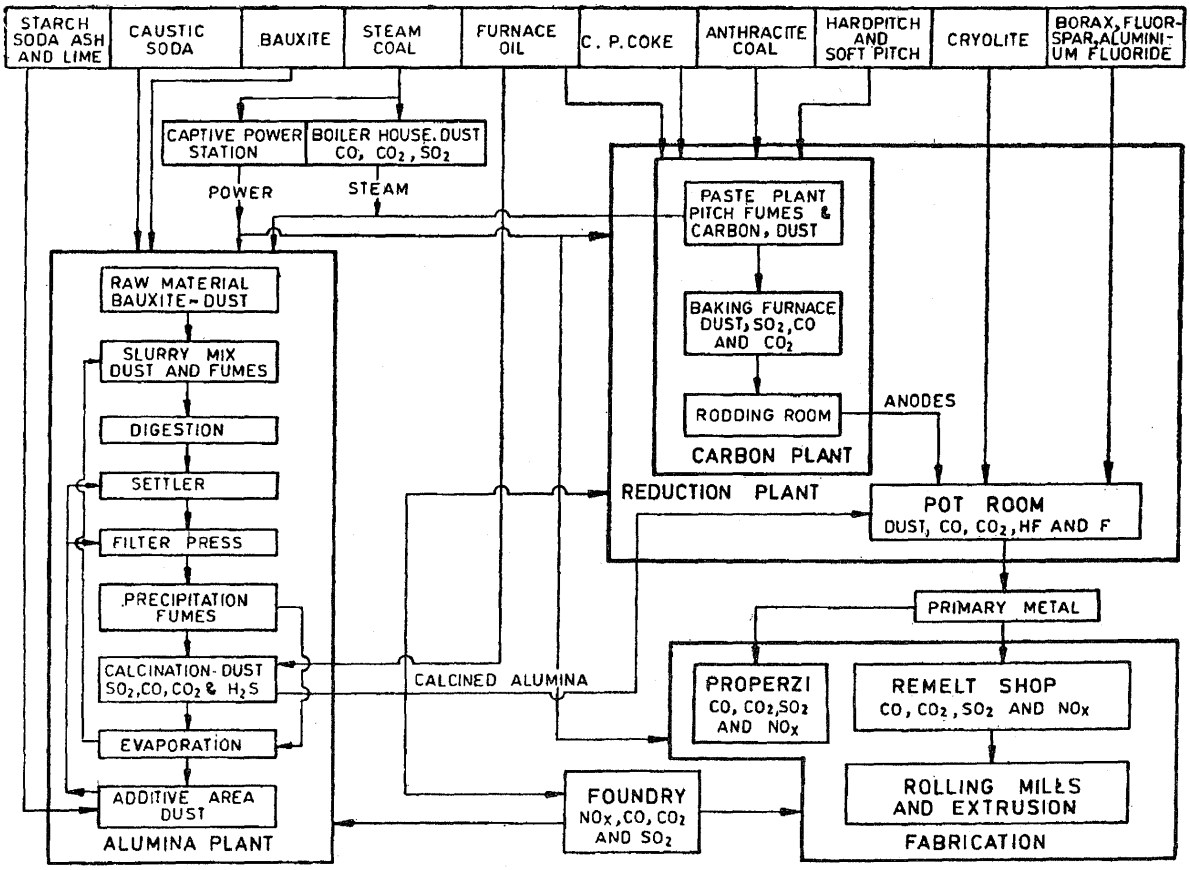

FIG. 1 SOURCES OF AIR POLLUTION IN AN INTEGRATED ALUMINIUM FACTORY

SECTION	ELECTRO-STATIC PRECI-PITATOR	FABRIC FILTER (DUST COLLECTOR)	MEDIUM DIA CYCLONE	BATTERY CYCLONE. SMALL DIA	WET SCRUBBER	HOOD AND CHIMNEY	MIST ELIMI-NATOR	VENTURI SCRUBBER
RAW MATERIAL		✓			✓		✓	
SLURRY MIX						✓		
DIGESTION								
CLARIFICATION								
FILTER PRESS								
PRECIPITATION								
CALCINATION	✓			✓				
EVAPORATION								
ADDITIVE AREA		✓			✓	✓		
PASTE PLANT		✓		✓				
BAKING FURNACE						✓		
RODDING ROOM								
POT ROOM					✓			✓
REMELT SHOP						✓		
PROPERZI						✓		
ROLLING MILLS AND EXTRUSION								
BOILER HOUSE	✓			✓				
THERMAL POWER PLANT	✓			✓				
FOUNDRY						✓		

FIG. 2 LIST OF RECOMMENDED DUST AND MIST COLLECTORS

1. SCOPE

1.1 This standard prescribes a code for controlling air pollution from various processes/sections of an integrated aluminium complex. The code covers the following:

a) Air pollutants, their sources and techniques of air pollution control;

b) Location and lay-out;

c) Air pollution survey; and

d) Emission factors.

2. AIR POLLUTANTS, THEIR SOURCES AND TECHNIQUES OF AIR POLLUTION CONTROL

2.1 Raw Materials

2.1.1 *Brief Description of the Process* — In an integrated aluminium industry, a large quantity of raw materials like bauxite, steam, coal, calcined petroleum coke, pitch, furnace oil, etc, are handled. Dust is produced while unloading the wagons, subsequent crushing, conveying by belt conveyors, transferring to storage points and reclaiming. Separate handling systems are provided generally for different raw materials.

2.1.2 *Generation of Air Pollutants* — A lot of dust is produced, particularly in the dry season, during the handling of raw materials in wagon tippler, conveyors, transfer points, crushers, etc, right up to the discharge points.

2.1.3 *Measures to Control Air Pollution* — The concentration of dust in the air should be maintained within the prescribed limits. For this purpose, suitable dust collectors of dry or wet type and also either of the pressure or the vacuum type depending on the conditions shall be provided. Dry type dust collectors like bag filters and cyclones shall be used depending on the application. Dust suppression by water spray can also be done at locations like wagon tippler during the dry season.

2.1.4 Generation of dust can also be minimized by small modification in the process of raw materials handling. These include reduction in number of transfer points, hooding of dust generating equipment, etc. In an aluminium industry normally raw material unloading, crushing, transfer and conveying operations need to be checked and proper hoods and ducting leading to common dust collection system in various sections have to be provided.

2.2 Slurry Mixing Area

2.2.1 *Brief Description of the Process* — In the slurry mixing area, the crushed bauxite is ground in ball mills or rod mills with process liquor (sodium aluminate solution), the slurry consistency varies from 3 to 50 percent depending on the process adopted. This is subsequently charged to the digesters at a measured rate.

2.2.2 *Generation of Air Pollutants* — In the slurry mixing area, normally a small quantity of caustic vapour gets entangled with the fumes generated during transfer of the bauxite slurry.

2.2.3 *Measures to Control Air Pollution* — The fumes generated at the ball mill discharge are vented out and do not contain any toxic contaminants. However, a small hood with a chimney leading to the top of the building may be adequate.

2.3 Digestion Plant

2.3.1 *Brief Description of the Process* — In the digestion area, the bauxite slurry is digested in digesters under different conditions like low pressure or high pressure digestion, the condition depending on the quality of the bauxite used. During the process of digestion of the bauxite slurry, additional quantities of steam and spent liquor are added into the digesters. Alumina from the bauxite is extracted and the insolubles remain in the form of red mud. Subsequently, pressure and temperature of the slurry is brought down gradually in flash tanks. The flashed steam so liberated is used for pre-heating of liquor. Slurry from the last flash tank is pumped to the clarification area for further processing. The condensate generated in the heaters is sent back to boiler area for converting to steam again.

2.3.2 *Generation of Air Pollutants* — Normally there is no emission of air pollutants from the digestion area. The steam and other vapours escaping out of the relief tanks and heater vents have to be screened by proper entrainment separators to avoid caustic vapours which may arise during process upsets.

2.4 Clarification and Filtration Area

2.4.1 *Brief Description of the Process* — The digested slurry from the digestion area is pumped to the clarification area for removing the red mud (impurities) from the pregnant liquor or green liquor (saturated sodium aluminate liquor). Slurry enters conventional thickeners where flocculants are also added. The settled red mud is pumped through a series of counter current washers to recover entrained caustic soda. After the last stage of washing, the mud is either filtered or directly pumped to red mud ponds. The clear overflow of sodium aluminate from the thickeners is then filtered in pressure filters to remove the finer

particles of impurities and then pumped to the next section which is precipitation section. The filtered cake is pumped to the washer system for subsequent disposal to red mud lake.

2.4.2 *Generation of Air Pollutants* — In the clarification and filtration area also, no toxic air pollutants are generated.

2.5 Precipitation Area

2.5.1 *Brief Description of the Process* — The saturated sodium aluminate solution is fed into batch type or continuous type of precipitators. Alumina hydrate seed is then added to the precipitators and the mixture is agitated either with compressed air or mechanically for over 25 to 30 hours.

2.5.1.1 In the case of continuous precipitation, the liquor moves from one precipitator to the subsequent one continuously and a time of approximately 60 to 70 hours is given. Selection of the precipitation system depends on the product quality requirement.

2.5.1.2 During this process, alumina hydrate precipitates from the saturated sodium aluminate solution. Hydrate so precipitated is classified either in thickners or by filtration. Out of the classified hydrate, the coarser fraction is calcined to give product alumina. The finer fractions are used for seeding.

2.5.2 *Generation of Air Pollutants* — The main air pollutant in this area is only the fine particles of caustic fumes coming out of the open type of precipitators. The effect of this vapour is felt mostly in the working area only. Of course, when there is excessive vapour coming out, it can be carried by high velocity wind to nearby areas in the plant.

2.5.3 *Measures to Control Air Pollution* — The formation of excessive mist or vapour with the air coming out of the precipitators is to be avoided by controlling the quantities of air or by providing proper covers. By exercising proper control on the operating parameters like quantity of air, type of agitation and temperature of the liquor, the emission of the vapour can be more or less reduced to minimum. The workers working in the area should be advised to use face and hand creams.

2.6 Calcination Area

2.6.1 *Brief Description of the Operating Process* — In the calcination area, the precipitated product hydrate is filtered, washed free of caustic soda and other impurities and fed into rotary kilns or calciners. The rotary kilns are fired by furnace oil (This is true for all the existing aluminium industries in India). The calcination of alumina hydrate to alumina takes place at a temperature of around 1 100°C. The calcinated alumina

is stored in silos or transferred to the smelter area. In case of some plants, where the smelter is located far away from the alumina facility, transportation is done by rail, road or ships.

2.6.2 *Generation of Air Pollutants*

2.6.2.1 Dusting is produced during the calcination of alumina hydrate to alumina. Dust emission is present in the main exhaust chimney of I.D. fan and also in the exhaust points of the bag filter house fans.

2.6.2.2 Dusting is produced at each and every transfer/collection point of the calcined alumina along with the conveyors.

2.6.2.3 Gaseous pollutants are generated during the burning of furnace oil in the rotary kilns and these escape through the I.D. fan chimney together with particulate matter. The gaseous pollutants may contain hydrogen sulphide, sulphur dioxide, carbon dioxide, carbon monoxide and particulate matter.

2.6.3 *Measures to Control Air Pollution* — The following measures should be taken to control air pollution:

a) Control of emission of alumina dust particles with the stack gases,

b) Control of gaseous pollutants in the stack gases, and

c) Control of alumina dust at transfer and conveying points of calcined alumina.

2.6.3.1 Alumina dust can be controlled by providing proper cyclones and a good electrostatic precipitator. Efficient dust collecting system at this point can practically eliminate any alumina going out through the stack gases.

2.6.3.2 The pollutants in the stack gases can be controlled only by exercising proper control on the combusted parameters of furnace oil. The stack height should be properly designed for dispersion and dilution of the gases after discharging to atmosphere.

2.6.3.3 Local exhaust ventilation hoods should be provided at each transfer point and above other points where dusting is produced. The exhaust air should be led to a central dust collection system which are normally bag filters.

2.7 Evaporation Area

2.7.1 *Brief Description of the Operating Process* — In the evaporation area, the spent liquor coming out of the precipitation area is evaporated for the purpose of maintaining water material balance in the process circuit.

The concentration of caustic soda is increased during this process and the evaporated liquor then circulated to the digester through spent liquor heaters for dissolving more alumina.

2.7.2 *Generation of Air Pollutants* — There are no air pollutants generated in this particular area.

2.8 Additive Area

2.8.1 *Brief Description of the Operating Process* — During the process of manufacture of alumina, certain important additives are used, which are generally prepared in the additive area and a few are listed below:

a) Slake lime in the form of lime slurry is added at various stages of the alumina manufacturing process. The purpose of this addition is to control the causticity of the process liquor and also in some cases to eliminate phosphate and to reduce organic contaminant levels in the process.

b) Synthetic or natural flocculants are added for enhancing setting characteristics of red mud and hydrate.

c) 'Filter aids' are prepared for precoating filters where sodium aluminate solution is filtered for removing impurities.

2.8.2 *Generation of Air Pollutants* — The air pollutants generated in this area are as follows:

a) Huge amount of dust is generated during handling of quick lime. The lime is usually received by trucks or wagons and unload into hoppers. Lime is crushed before it is slaked in lime slakers. The entire lime handling operation is a dust generating operation.

b) Some amount of dust is also generated during handling of materials like flocculants, particularly, where the natural flocculants like starch is used.

2.8.3 *Measures to Control Air Pollution* — Dust generated during handling of lime should be preferably absorbed in a wet scrubbing unit using water and the collected dust together with water should be re-circulated to the lime slaker. Proper hooding with natural exhaust will be adequate for taking care of the dust during handling of flocculants.

2.9 Reduction Plant

2.9.1 *Carbon Plant Area*

2.9.2 *Brief Description of the Operating Process* — The carbon plant area is normally located in the reduction plant or smelter. In the cells used for pot electroytic reduction of aluminia to aluminium, the anode is

made of carbon and cathode is also a lining of carbon. During the process, the anode carbon gets consumed continuously and this has to be replenished. The carbon plant manufactures and supplies the anode in the form of prebake blocks or anode paste depending on the type of smelter operation. The anode is prepared by mixing powdered calcined petroleum coke with medium soft pitch. In case of prebake anode plant, the green anodes in the form of anode blocks are baked in baking furnace fired by furnace oil at a temperature around 1 150°C. The baked anodes are then fixed with anode stubs and copper rods for subsequent replenishment in the potroom. In the other type, namely, the Soderberg type cells, the anode paste is directly charged to the pots.

2.9.3 *Generation of Air Pollutants* — A lot of carbon dust is produced during handling, conveying and crushing operations of calcined petroleum coke. Pitch fumes are also generated during the melting of pitch. In the baking furnace, the exhaust fans which continuously exhaust the furnace throw out stack gases containing carbon monoxide, carbon dioxide and sulphur dioxide.

2.9.4 *Measures to Control Air Pollution* — The best method of collecting the dust in the CP coke handling and crushing area is to provide proper hoods with ducting leading to a bag filter type dust collection arrangement. Properly designed bag filters for this application have been found to be very effective in controlling the dust level in the working area and in the environment.

2.9.4.1 Pitch fumes can also be controlled by scrubbing, providing proper hoods and stacks.

2.9.4.2 In the baking furnace, an efficient control on the combustion of furnace oil will take care of the composition of the stack gases. The chimney which exhaust gases from the baking furnace should also be high enough to disperse gases over a wide area thereby ensuring proper dilution.

2.10 Potroom

2.10.1 *Brief Description of the Operation Process* — The potroom is the main plant area of an integrated aluminium complex. The potroom consists of facilities like pot cells, electrical bus bars, cranes, etc, for carrying out reduction operation. The pot cell is lined with a layer of carbon which forms the cathode. Anode carbon blocks are suspended from the top frame. Heavy DC current varying from 55 000 to 100 000 amperes depending on the design of the plant, is passed through the cell. The cell is filled with a bath of cryolite, sodium aluminium fluoride and aluminium fluoride. Alumina gets dissolved in the molten cryolite and due to the passage of the high current, it gets electrolyzed to aluminium and oxygen. The oxygen combines with the carbon anode and escapes

into the atmosphere as carbon dioxide. The molten aluminium collects at the cathode and is intermittently tapped out into a crucible using cast iron syphon. The molten aluminium thus tapped is transferred to the pig casting area or to the remelt casting shop of fabrication.

2.10.2 *Generation of Air Pollutants* — In an integrated aluminium industry, the smelter happens to be the area producing maximum amount of air pollutants. The smelter operation is carried out at a temperature of about 960 to 970°C. The bath contains fluorine combined with dust particulates. During various operations in the potroom, a lot of dust particulate and also gaseous contaminants are produced. The gaseous contaminants are mainly carbon-dioxide, gaseous fluorine, gaseous hydrofluoric acid, some volatile fluorides of silica, iron and suspended particles of alumina, aluminium fluoride, cryolite and carbon.

2.10.3 *Measures to Control Air Pollution* — The control of air pollution from aluminium smelter has been studied on an international basis. Basically there are two methods of air pollution control. One is a wet scrubbing method and the other is dry scrubbing method. The wet scrubbing method for the potroom gases being an old method and having its own problems like corrosion, cumbersome operation, etc. The dry scrubbing system is by and large being universally accepted by many modern aluminium industries using prebaked pots. Dry scrubbing system is not applicable to Solderberg pots; only wet scrubbing system is used in these pots. In the dry scrubbing system, the pots are properly hooded and the gases collected through the ducting of central scrubbing unit where alumina is used for scrubbing. The alumina adsorbs more than 98 percent of the gaseous flourine contaminants of the gases. These gases then are passed through an efficient bag filter system where the particulate matters is also removed and recycled to the process. The gases coming out of the bag filter which are free from gaseous and particulate contaminants, are discharged into the atmosphere through high stacks.

Provision of a dry scrubbing system for older type of plants is lengthy and costly proposition, and necessary time factors may be allowed for implementation of the schemes. So the scrubber selection will depend upon the types of pots used, namely, prebaked or Solderberg.

At all points where alumina, aluminium fluorides and cryolite are handled inside the reduction plant, proper care should be taken to avoid dusting by controlling the operations, provision of telescopic chutes, hooding, wherever necessary, etc.

2.11 Fabrication Plant

2.11.1 *Brief Description of the Operating Process* — By and large, the following processes are involved in aluminium fabrication line:

a) Remelting and casting operations,
b) Production of electrical conductor grade properzi rods,
c) Production of extruded sections,
d) Hot rolling of aluminium slabs into sheets,
e) Cold rolling of aluminium sheets,
f) Production of aluminium paste and powder, and
g) Production of aluminium foils.

2.11.2 *Generation of Air Pollutants* — The only section where air pollutants are generated in the fabrication plant is the remelting section. Furnace oil is generally burned in the melting furnaces and gases coming out of the stacks of these furnaces contain pollutants like SO_2, CO_2, CO, chlorides, and NOx. The contaminants can be controlled to some extent by proper combustion of the oil. The stack should be high enough to ensure proper dispersion of the stack gases. Recuperators or heat conserving methods should be adopted to reduce the temperature of the exhaust gases to the minimum possible.

2.12 Boiler Plant for Process Steam

2.12.1 *Brief Description of the Operating Process* — A boiler plant with suitable capacity is required for supplying process steam to the alumina plant, carbon plant and some other auxiliaries of aluminium industry, The process steam is supplied to processes like digestion, evaporation, cleaning, additives preparation, furnace oil heating, etc.

2.12.2 *Generation of Air Pollutants* — Depending on the type of boilers and the quality of coal, good amount of fly ash, dust and stack gases containing sulphur dioxide and nitrogen oxide are generated in the boiler area. The coal handling also generates coal dust at unloading, transfer and conveying points.

2.12.3 *Measures to Control Air Pollution* — Boiler should by provided with multi-cyclones and electrostatic precipitators, if found necessary, so as to maintain the particulate matters in the stack gases within acceptable limits. It has been found that normally electrostatic precipitator for such applications is not very efficient due to the low sulphur content in the Indian coal. An efficient cyclone separator or a multicyclone properly designed should serve the purpose.

2.12.4 Bag filter shall be provided for collecting the dust emanating from the coal handling area, hoods and proper ducting shall be provided at dusting and they should be led to the central dust collection bag house.

2.13 Captive Power Plants

2.13.1 Captive power plants generate and supply electric power to the aluminium industry. Presently there is only one such unit in the country. The existing one is a thermal power plant.

2.13.2 *Generation of Air Pollutants* — As already mentioned under boilers for process steam, the thermal power stations also generate air pollutants due to sulphur dioxide, particulate contaminants and nitrogen oxides. The emission limits may vary from unit to unit depending on the capacity of the plant, ambient air quality level, wind speed directions, chimney height and topography.

2.13.3 *Measures to Control Air Pollution* — Generally, it is possible to minimize air pollution caused by thermal power stations and boilers by proper design of stacks, adopting multi-flue stacks (for new units only) and by providing cyclone separators and/or electrostatic precipitators. Bag house is also efficient dust collecting equipment.

2.14 Foundry

2.14.1 *Brief Description of Operating Process* — Foundry unit is provided as an auxiliary unit in or around an integrated aluminium industry. The purposes of the foundry are generally for making indigenous spare parts for various equipments deployed in the plant.

2.14.2 *General Air Pollutants* — The main atmospheric pollutants are produced during the melting of cast iron scrap. The gases coming out of the melting furnace contain oxides of nitrogen, sulphur and carbon monoxide.

2.14.3 *Measures to Control Air Pollution* — Generally the foundries are intermittent operating plants and do not cause any serious air pollution. However, the chimneys of the furnace should be properly designed and should be high enough to ensure effective dispersion and dilution.

3. LOCATION AND LAYOUT

3.1 While deciding the location for new aluminium complex or expansion of the existing operations, environmentally acceptable approach has to be ensured. This task will include:

a) Selection of best site for smelters particularly;

b) the best technology available for the industry be adopted;

c) cleaning equipments be installed together with the whole plant;

d) cleaning equipments have to comply with specifications;

e) it is advisable to monitor air pollution levels before start up of the plant;

f) the plant should be so located that the predominant wind direction carries the gases away from the residential localities and green belts; and

g) alternately, residential area should be located towards the clearner side of the plant.

3.2 Stacks

3.2.1 All stacks should be designed such that emission of particulate matter from the stacks should be within the prescribed limits. Proper dispersion at reasonable heights shall also be ensured.

4. Air Pollution Survey

4.1 It is advisable to conduct air pollution survey of the locality around new plants or proposed expansion. Pollution control unit of the plant should be designed to take care of the already existing background pollution level.

4.2 All integrated aluminium industries should have independent pollution monitoring facilities. A systematic record of the emissions in working area and also in the ambient air within a diameter of 5 km should be maintained by the pollution monitoring and control group. A fully equipped analytical laboratory and trained personnel is an asset to the industry.

5. EMISSION FACTORS

5.1 The emission factors for primary aluminium process are as given in Table 1 and **5.1.1**.

5.1.1 Sulphur oxides may be estimated, with an emission factor rating of *C*, by the following calculations:

a) Anode baking furnace, uncontrolled SO_2 emissions (excluding furnace fuel combustion emissions) : $20\ (C)\ (S)\ (1-0{\cdot}01\ K)$ kg/t

b) Prebake (reduction) cell, uncontrolled SO_2 emissions:

$$0{\cdot}2\ (C)\ (S)\ (K)\ \text{kg/t}$$

where

C = anode consumption [weight of anode paste (coke + pitch) before baking] during electrolysis, kg anode consumed/kg alumina produced.

S = percent sulphur in anode before baking.

K = percent of total SO_2 emitted by prebake (reduction) cells.

TABLE 1 EMISSION FACTORS FOR PRIMARY ALUMINIUM PRODUCTION PROCESS

(*Clause* 5.1)

Operation	Total Particulate* kg/t	Gaseous Fluoride kg/t	Particulate Fluoride kg/t
Anode Raking			
Uncontrolled	1·5	0·45	0·05
Fugitive	←——————Not available——————→		
Spray tower	0·375	0·1	0·05
Electrostatic precipitator (ESP)	0·375	0·1	0·05
Dry alumina scrubber	0·03	0·01	0·02
Prebake Cell			
Uncontrolled	47·0	12·0	10·0
Fugitive	2·5	0·6	0·5
Emission to collector	44·5	11·4	9·5
Multiple cyclones	9·8	11·4	2·1
Dry alumina scrubber	0·9	0·65	0·85
Spray tower	8·9	1·5	2·0
Coated bag filter dry scrubber	0·9	1·7	0·2
Vertical Soderberg Stud Cell			
Uncontrolled	39·0	16·5	5·5
Fugitive	6·0	2·45	0·85
Emission to collector	33·0	14·05	4·65
Spray tower	8·25	0·15	1·15
Venturi scrubber	1·3	0·7	0·8
Multiple cyclones	16·5	14·05	2·35
Dry alumina scrubber	0·65	0·75	0·75
Horizontal Soderberg Stud Cell			
Uncontrolled	49·0	11·0	6·0
Fugitive	5·0	1·1	0·6
Emission to collector	44·0	9·9	5·4
Spray tower	11·0	3·75	1·35
Floating bed scrubber	9·7	0·3	1·2
Scrubber plus wet ESP	0·9	0·3	0·7
Wet ESP	0·9	0·8	0·7
Dry alumina scrubber	0·9	0·75	0·75

*Includes particulate fluoride.

(*Continued from page* 2)

Codes of Practice for Control of Air Pollution Subcommittee, CDC 53 : 4

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INTERNATIONAL SYSTEM OF UNITS (SI UNITS)

Base Units

Quantity	Unit	Symbol
Length	metre	m
Mass	kilogram	kg
Time	second	s
Electric current	ampere	A
Thermodynamic temperature	kelvin	K
Luminous intensity	candela	cd
Amount of substance	mole	mol

Supplementary Units

Quantity	Unit	Symbol
Plane angle	radian	rad
Solid angle	steradian	sr

Derived Units

Quantity	Unit	Symbol	Definition
Force	newton	N	1 N = 1 kg.m/s^2
Energy	joule	J	1 J = 1 N.m
Power	watt	W	1 W = 1 J/s
Flux	weber	Wb	1 Wb = 1 V.s
Flux density	tesla	T	1 T = 1 Wb/m^2
Frequency	hertz	Hz	1 Hz = 1 c/s (s^{-1})
Electric conductance	siemens	S	1 S = 1 A/V
Electromotive force	volt	V	1 V = 1 W/A
Pressure, stress	pascal	Pa	1 Pa = 1 N/m^2